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AN EXPERIMENTAL STUDY ON NON-DESTRUCTIVE TESTS AND STRESS STRAIN CURVES OF M20 GRADE CONCRETE WITH NANO-SILICA USING M-SAND

G. Prasanna Kumar
Assistant Professor, Civil Engineering Department, AITAM College, Tekkali, Srikakulam, India

G. Durga Rama Naidu
Assistant Professor, Civil Engineering Department, AITAM College, Tekkali, Srikakulam, India

P. Puspalatha
Assistant Professor, Civil Engineering Department, AITAM College, Tekkali, Srikakulam, India

P. Manoj Kumar
Assistant Professor, Civil Engineering Department, AITAM College, Tekkali, Srikakulam, India

ABSTRACT

Concrete is the world's most widely used construction material because of its versatility, durability, sustainability, and economy. The term concrete refers to a mixture of aggregates, usually sand, and either gravel or crushed stone, held together by a binder of cementitious paste. In India, the conventional concrete is mostly produced by using natural sand obtained from the riverbeds as fine aggregate. One of the important ingredients of conventional concrete is natural sand or river sand. However, due to the increased use of concrete in almost all types of construction works, the demand of natural or river sand has been increased. Thus in order to meet these increased demands of construction industry, excessive quarrying of sand from river beds is taking place which results in the shortage of natural sand. This scarcity of natural sand has forced engineers to find a suitable substitute. One of the best ways of getting substitute for natural sand is by crushing natural stone to get artificial sand of desired size and grade .The use of artificial sand will conserve the natural resources for sustainable development of the concrete in construction industry. Hence the practice of replacing river sand with M-Sand is taking a tremendous growth.

In the present study the ordinary portland cement is partially replaced with nanosilica by 2% and natural sand is replaced with manufactured sand in different proportions of 0%,25%,50%,75%,100%.The non destructive tests were performed

such as rebound hammer test and ultrasonic pulse velocity method.Here stress strain curves were also plotted along with the calculation of Youngs Modulus.

Key words: compressive strength, manufactured sand, nano silica, pulse velocity, youngs modulus..

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1. INTRODUCTION

Sand is one of the major components of construction aggregates used for masonary and plastering to concreting and finishing works. Its composition is highly variable depending on the local sources and conditions. Historically sand has been sourced from alluvial deposits like river beds, sea shores and deep earth pits. Its physical composition emerges in different types like the fine, medium and coarse varieties, based on granular size and shape. River sand is a product of natural weathering of rocks over a period of millions of years. It is formed by erosion factors such as water movement on a beach. It is mined from the river bed. Sand mining has disastrous environmental consequences. River sand is becoming a scarce commodity and hence exploring alternatives to it has become imminent. However environmental pressures, high costs and shortage of natural sources has necessitated manufacturing of sand from quarried material. Rock crushed to the required grain size distribution is termed as manufactured sand (M-sand) which is defined as a purpose-made crushed fine aggregate produced from a suitable source material.

Recently Nano Technology has been introduced in Civil Engineering applications. Nano Silica (NS) is the most important material use in nano technology. This is the first nano product that has replaced the micro silica. Nano silica possess more pozzolanic nature, it has the capability to react with the free lime during the cement hydration and forms additional C-S-H gel which gives strength, impermeability and durability to concrete.

2. RESEARCH SIGNIFICANCE

This study is an attempt to evaluate the characteristics of concrete using M-sand as fine aggregate. For the purpose of comparison, characteristics of concrete with river sand have also been explored.

The non destructive tests such as rebound hammer test and ultrasonic pulse velocity method were conducted to assess the quality and homogeneity of both the mixes.

To calculate the Young's modulus of M20 grade concrete with all the different proportions of manufactured sand without and with addition of 2 % of nano silica.

3. MATERIALS AND PROPERTIES

Cement: JAYPEE Ordinary Portland Cement of 43 Grade confirming to IS 8112-1989 of specific gravity 3.12.

Fine Aggregate: River sand and Manufactured sand confirming to Zone-II of IS 383.

Coarse Aggregate: Crushed granite metal with 60% passing 20 mm and retained on 10 mm sieve and 40% passing 10mm and retained on 4.75 sieve was used.

Water: Potable water confirming to IS: 456-2000.

Nano Silica: Nano Silica CEM SYN XTX type

Table 1 Properties of nano silica

Notation of Nano Silica Gel	CEM SYN XTX
Active nano content (%wt/wt)	30.0-32.0
pH	9.0-10.0
Specific Gravity	1.20-1.22

4. METHODOLOGY AND EXPERIMENTAL INVESTIGATION

Experimental study was performed in order to provide sufficient information about the strength characteristics of manufactured sand concrete and natural sand concrete with and without using nano silica and their comparison. Non destructive tests such as Rebound hammer test and ultrasonic pulse velocity test (UPV) were conducted on M20 grade concrete along with different proportions of M-sand and results were analysed.

5. TEST RESULTS

Table 2 Variation of Compressive Strength of M20 Grade Concrete with different proportions of Manufacture Sand without and with 2% nano silica using Rebound Hammer Test.

S.No	Description	Without Nano Silica	With 2% Nano Silica
		Compressive Strength(N/mm^2) 28 Days	Compressive Strength(N/mm^2) 28 Days
1.	M20 + 0% M-Sand	27.5	22.5
2.	M20 + 25% M-Sand	26.4	23.9
3.	M20 + 50% M-Sand	25	25.25
4.	M20 + 75% M-Sand	24.5	26
5.	M20 + 100% M-Sand	35	22

Table 3 Pulse Velocity and Quality of M20 Concrete with different proportions of Manufactured Sand without and with addition of 2% nano silica by using ultrasonic pulse velocity test (UPV).

S.No	Description	Without Nano Silica		Concrete Quality
		µs	Velocity (m/s)	
1.	M20 + 0% M-SAND	31.4	4777	Very Good To Excellent
2.	M20 + 25% M-SAND	32.4	4630	Very Good To Excellent
3.	M20 + 50% M-SAND	30.9	4854	Very Good To Excellent
4.	M20 + 75% M-SAND	30.9	4854	Very Good To Excellent
5.	M20 + 100% M-SAND	31.4	4777	Very Good To Excellent

Table 4 Variation of Youngs Modulus of M20 Grade Concrete with different proportions of Manufacture Sand without and with 2 % nano silica.

S.NO	Description	Youngs Modulus(N/mm^2)	
		Without Nano Silica	With 2% Nano Silica
1.	M20+0% M-SAND	23000	21600
2.	M20+25%M-SAND	22000	20500
3.	M20+50% M-SAND	22700	19200
4.	M20+75%M-SAND	21250	24160
5.	M20+100%M-SAND	23125	22670

6. DISCUSSIONS

- It is observed that the compressive strength of concrete obtained by Rebound hammer test at 28 days is more for 100 % replacement of natural sand with manufactured sand. Whereas for addition of 2% of nano silica the compressive strength of concrete at 28 days is more at 75 % replacement of natural sand with manufactured sand.
- It is observed that the ultrasonic pulse velocity of concrete at 28 days is more at 50 % and 75 % replacement of natural sand with manufactured sand where as with the addition of 2% nano silica it is more at 0% and 75% replacement of natural sand with manufactured sand.
- The values of modulus of elasticity of concrete is maximum at 100% replacement of natural sand by manufactured sand and is 1% higher than the normal aggregate concrete. Whereas concrete with 2 % of nano silica shown higher value at 75% replacement by 11.85 % when compared to normal concrete.

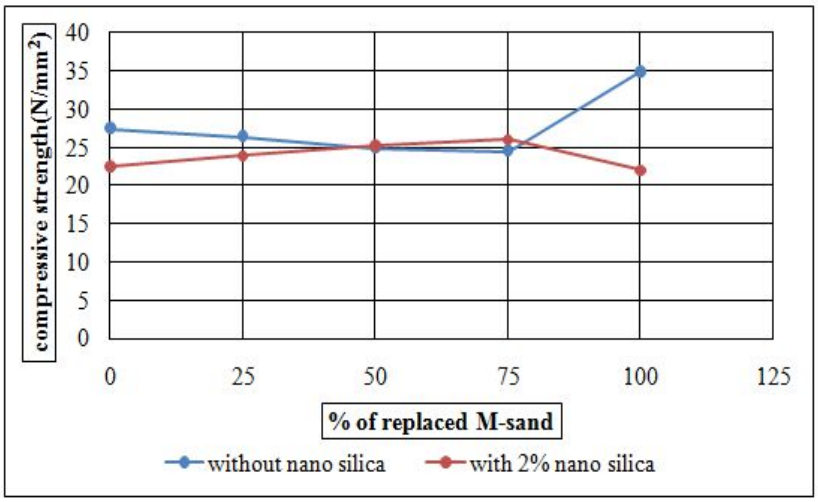

Figure 1 Variation of 28 Days Compressive Strength with different proportions of M-sand forM20 Grade Concrete without and with addition of 2% of Nano Silica

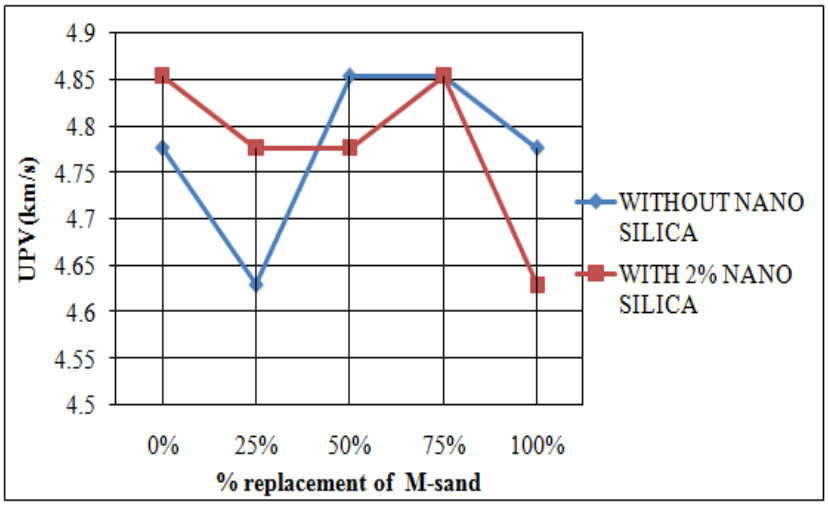

Figure 2 Variation of ultrasonic pulse velocity with % of replacement of M-sand for M20 Concrete without and with 2% nano silica

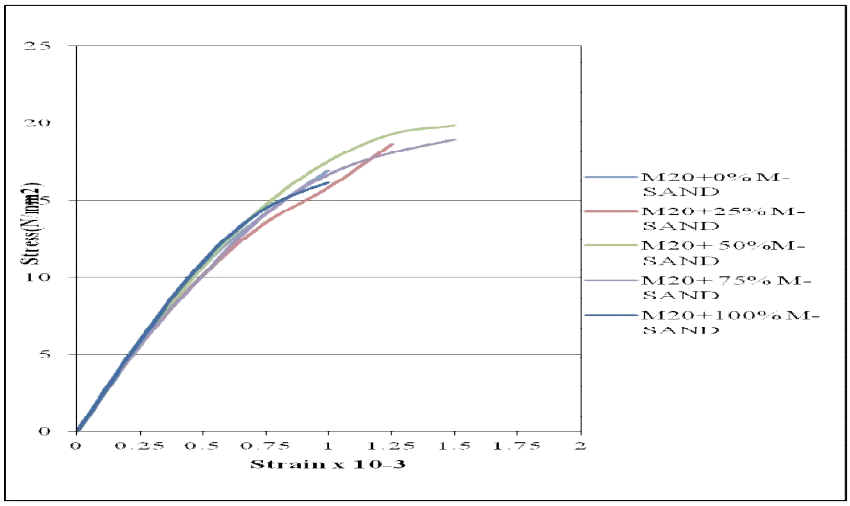

Figure 3 Stress- Strain Curves for M-20 concrete with % replacement of natural sand with M-sand without addition of nano silica at 28 days

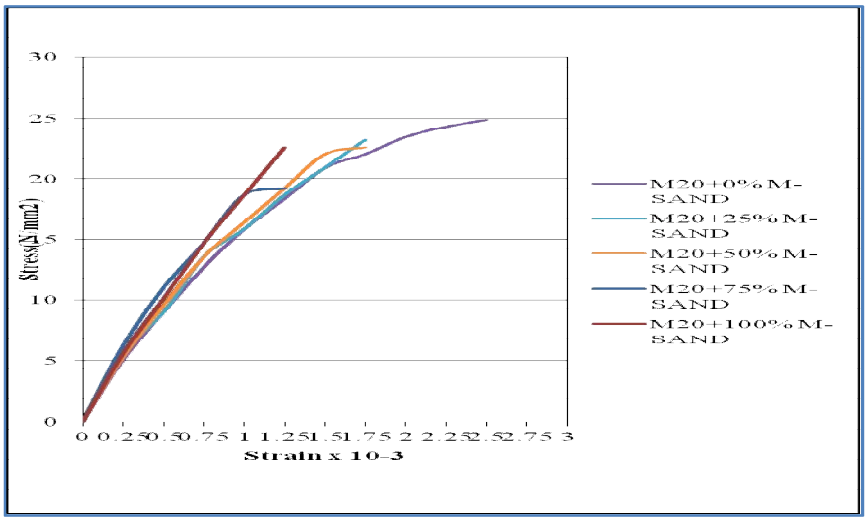

Figure 4 Stress- Strain Curves for M-20 concrete with % replacement of natural sand with M-sand without addition of nano silica at 28 days

7. CONCLUSIONS

The following conclusions were drawn from the results considering the non-destructive tests of concrete made with replacement of natural sand with manufactured sand in different proportions for M20 grade.

- Manufactured sand is a good alternative for natural sand as fine aggregate.
- The presence of nano silica improves the strength of concrete with manufactured sand at early ages when compared to normal concrete.
- Values of compressive strength obtained based on Non Destructive Test like Rebound Hammer are found to be satisfying the requirements of IS codes for both the mixes without and with 2% addition of nano silica and assessed as good.
- Similarly the quality of both concrete mixes for M20 grade based on Ultrasonic Pulse velocity(UPV) test are found to be good and satisfactory.
- It is clearly understood that the modulus of elasticity is increased with the increase in percentage replacement of natural sand with of manufactured sand.

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